Introduction – Resource Management Strategies

A key objective of the California Water Plan is to present a diverse set of resource management strategies to meet the water related resource management needs of each region and the state as a whole. Chapter 4 of Volume 1 describes the importance of regional planning and presents general considerations for preparing sustainable integrated resource plans suitable for each region's unique character. This volume describes 25 resource management strategies (listed alphabetically in the adjacent box and in narratives following the introduction) that can be combined in various ways to meet the water management objectives and values of different regions and to achieve multiple resource benefits.

What are Resource Management Strategies?

As used in this report, a resource management strategy is a project, program or policy that helps California's local agencies and governments manage their water and related resources. For example, urban water use efficiency to reduce urban water use is a strategy. A pricing policy or incentive for customers to reduce water use is also a strategy. New water storage to improve water supply, reliability or quality is a strategy.

Some may like to think of these strategies as individual tools in a tool kit. Just as the mix of tools in a tool kit will vary depending on the job to be performed, the combination of strategies will vary from region to region depending on the individual situations surrounding their water supply and use, climate, projected growth, and environmental and social conditions. Some strategies may have little value in some regions. For example, due to geologic conditions, the opportunity for groundwater use in the mountain counties is not nearly as significant as in the Sacramento Valley.

Resource Management Strategies

Agricultural lands stewardship
Agricultural water use efficiency
Conjunctive management
Conveyance
Desalination
Drinking water treatment and distribution
Economic incentives (Loans, Grants, and Water Pricing)
Ecosystem restoration
Floodplain management
Groundwater remediation / Aquifer Remediation
Matching water quality to use
Other strategies
Pollution prevention
Precipitation enhancement
Recharge area protection
Recycled municipal water
Surface storage - CALFED/state
Surface storage - regional/local
System reoperation
Urban land use management
Urban runoff management
Urban water use efficiency
Water transfers
Water-dependent recreation
Watershed management

Planning a Diversified Portfolio

As conditions continue to change in California, many local agencies and governments continue to diversify their water management portfolios to meet human and environmental needs. Growing population, changing regulations, and evolving public attitudes are a few conditions that have influenced recent portfolio decisions for water and other resources. This diversification has become even more essential with the growing understanding of the concurrent water demands of farms, cities and the environment and the need to achieve multiple benefits.

The strategies described in this volume are the building blocks that local agencies and governments should consider in developing their future regional integrated resource plans. The basic intent is to prepare good plans that are diversified, satisfy regional and state needs, meet multiple objectives, are inclusive of public input, address environmental justice concerns, display and mitigate impacts, protect public trust assets, and are affordable. Recommendations for future planning and implementation can be found in Chapter 4 of Volume 1.

Resource managers need to examine all of these strategies to identify the best mix for their region. The more a region can diversify its portfolio, the more robust and resilient it will be in facing future unknowns.

While the strategies are based on the best available information, DWR has not conducted detailed studies to verify this information on a statewide basis because the performance of individual strategies will depend on how they are combined and used in each region. DWR, with the assistance of the Advisory Committee, is developing a work plan for more comprehensive and robust data and analytical tools for use in the Water Plan Update in 2008. Additional analyses under Phases 2 and 3 of the update process (described in Chapter 1 of Volume 1) will provide policy makers and resource managers more quantitative information on the performance of various strategies, interactions between strategies, tradeoffs, and potential groupings or packages of strategies. Because the future is uncertain and stakeholders have a range of perspectives on how strategies could be integrated, DWR will consider several different future scenarios in the future Bulletin 160-08 that can be used by planners to test the performance of alternative strategy mixes.

Organization of Resource Management Strategy Narratives

Following this introduction are articles on 25 resource management strategies. While the articles were written by different experts, the narratives for each strategy are arranged in a similar format:

- Each article begins with a short definition and background material on the strategy.
- A section on the current use of the strategy in California provides an overview of what is happening under today's conditions.
- A section on benefits includes a discussion on how much water supply, demand reduction, ecosystem restoration, or other benefits could be achieved on a statewide basis by 2030. Since the potential application of these strategies can vary widely among the various regions, the strategy descriptions are from a broader, statewide perspective. More detailed information on some of the strategies is also presented in the Reference Guide (Volume 4).
- The narratives include estimates on implementation costs when information is available. In most cases, costs are highly dependent on site specific implementation and can only be portrayed in broad ranges.
- It is also important to recognize that there are issues and challenges associated with implementing each strategy. For instance, with water transfers there are concerns about third-party impacts. With ocean water desalination there are issues with water intakes and brine disposal. For new off stream surface water storage there are questions about impacts of diversions on the rivers that would provide the water. With agricultural water use efficiency, there are potential impacts on downstream environmental resources dependent on tail water runoff.
- Each strategy narrative contains recommendations on how the strategy could be implemented over the next 25-30 years to minimize its impacts, as well as how to promote additional implementation. Many of the recommendations are for the state to enact technical support activities that will help the regional groups make better decisions for the use of the strategies. The narratives do not include

specific recommendations for funding implementation of individual strategies since local and regional efforts will need to complete additional analysis before making implementation decisions. However, each strategy will require funding if implemented.

While the resource management strategies are presented individually (and alphabetically) to simplify the presentation, the potential for synergistic effects and trade-offs should also be examined. For instance, water from a recycling project could contribute to ecosystem restoration and groundwater recharge; while upstream water use efficiency may reduce the opportunity for downstream recycling and reuse.

In addition, the strategy narratives and their related recommendations are designed to recognize the many interactions between water and other resources. However, DWR does not have authority over some of these resources, and other state and local agencies and governments will continue to set policy over the resources within their jurisdictions. As appropriate, these policies and programs are articulated in the various resource management strategy narratives.

Strategy Investment Options Table

The Strategy Investment Options Table (see following table) provides a one page overview of the 25 resource management strategy articles. DWR, in consultation with other experts and stakeholders, developed the data and information presented in the table and the narratives. The information is not directly comparable across strategies, but should be treated as preliminary indicators of the scale and type of potential benefits and associated estimated costs. In most cases, assumptions and methodologies are unique to given strategies and neither benefits nor costs are additive among different strategies. Costs of actually implementing these strategies in specific locations could be significantly less or greater depending upon the extent of implementation that has already occurred and other local factors. Local and regional water management efforts should develop their own estimates of both costs as well as potential water supply benefits associated with any particular strategy.

Note that the benefits in the table are displayed as average annual amounts in million acre-feet, but that costs are displayed as the sum (over about 25 years) of expected costs by year 2030. Neither the estimates of benefits nor costs are suited for estimating unit water costs.

Table Layout

The actions in the table are grouped by **resource management strategies** (top section) and **essential support activities** (bottom section), like planning and research & development. The table presents the resource management strategies in subgroups according to the type of strategy. Groupings include demand reduction, operational efficiency & redistribution of water, supply augmentation, water quality and resource stewardship. While these groupings are intended to aid review of the table, the 25 resource management strategy articles on the following pages are arranged in alphabetical order so they can be more easily located. Table columns include:

- **Column 1** shows the *Resource Management Strategies* (top section) and *Essential Support Activities* (bottom section) that are available to regions to achieve various water management objectives.
- **Column 2** shows the estimated *Potential Water Supply Benefits by 2030*, with a footnote describing which benefit would be achieved and data sources. These benefits are displayed as average annual amounts in million acre-feet per year. A dot (●) is shown for strategies that would have a supply benefit that could not be quantified at this time.

- **Columns 3-10** show other *Water Management Objectives* that could be achieved by implementing a strategy. A dot (●) is shown if a strategy could have direct and significant benefits for various water management objectives. In addition to these primary benefits shown with a dot (●), most strategies also provide other benefits as indicated in the strategy narratives.
- **Column 11** shows a range of *Cumulative Costs for each Option by 2030* of implementing a strategy or performing a support activity to achieve the indicated annual benefits by 2030 (not including ongoing operation and maintenance costs). These costs are displayed as the sum of costs over about the 25-year period. Details on implementation and financing are presented in Chapter 5.

Table Footnotes

General and specific notes are listed on the pages directly following the table.

Strategy Investment Options

	Water Management Objectives										
	Provide Water Supply Benefit MAF per year		Improve Drought Preparedness	Improve Water Quality	Operational Flex & Efficient	Reduce Flood Impacts	Environmental Benefits	Energy Benefits	Recreational Opportunities	Reduce GW Overdraft	Cumulative Cost of Option by 2030 Billion $	
Resource Management Strategies												
Demand Reduction												
Agricultural Use Efficiency	0.3 – 0.6	(a)		●			●				0.13 – 2.5	(b)
Urban Use Efficiency	1.5 – 2.5	(c)		●			●				staff	(d)
Operational Efficiency & Redistribution of Water												
Conveyance			●		●						1.13	(e)
System Reoperation	0.15	(f)			●	●	●					(g)
Water Transfers		(h)	●	●	●		●				staff	(i)
Supply Augmentation												
Conjunctive Management & Groundwater Storage	0.5 – 1.5	(j)	●	●	●					●	1.5 – 4.5	(k)
Desalination – Brackish	0.1 – 0.3	(l)	●	●							0.2 – 1.6	(m)
Ocean	0.2	(n)	●	●							0.7 – 1.3	(o)
Precipitation Enhancement	0.3 – 0.4	(p)	●					●			0.2	(q)
Recycled Municipal Water	0.9 – 1.4	(r)	●	●							6.0 – 9.0	(s)
Surface Storage – CALFED	0.7 – 1.0	(t)	●	●	●	●	●				3.3 – 5.6	(u)
Surface Storage – Regional/Local	●		●	●	●	●						(v)
Water Quality												
Drinking Water Treatment & Distribution				●							19.0 – 21.0	(w)
Groundwater/Aquifer Remediation	●	(x)	●	●	●						20.0	(y)
Matching Quality to Use			●	●							0.08	(z)
Pollution Prevention				●			●				15.0	(aa)
Urban Runoff Management			●	●		●	●					(bb)
Resource Stewardship												
Agricultural Lands Stewardship	●	(cc)		●		●	●				5.3	(dd)
Economic Incentives (Loans, Grants, and Water Pricing)	●	(ee)	●				●					(ff)
Ecosystem Restoration							●		●		7.5 – 11.25	(gg)
Floodplain Management						●	●		●		0.48	(hh)
Recharge Area Protection		(ii)	●	●						●		(jj)
Urban Land Use Management				●			●					(kk)
Water-Dependent Recreation									●		0.02	(ll)
Watershed Management				●		●	●				0.48 – 3.6	(mm)
Other Strategies	Objectives Vary by Strategy (See Narrative)											
Essential Support Activities to Integrate Strategies and Reduce Uncertainty												
Regional Integrated Resource Planning & Management											0.25	(nn)
Statewide Water Planning											0.12	
Data & Tool Improvement											0.25	
Research & Development											0.25	(oo)
Science											3 – 5% of total	(pp)

Notes for Strategy Investment Options Table

General Notes for Potential Water Supply Benefits by 2030 (shown in Column 2)

The ranges shown in Column 2 are estimates for potential demand reduction, redistribution of supply, and supply augmentation based on a review and aggregation of available information from existing studies.

Supply estimates may not be additive because various strategies can compete for the same water. For example, new surface storage may compete for the same water that could be used by conjunctive management strategies. The estimates may not be comparative because the estimates were derived from numerous studies based on different assumptions and data sources, as described below in Specific Notes (a) – (kk). In some cases, the values represent a local or regional benefit and may not provide statewide benefits. For example, water transfers that derive supply from land fallowing can redistribute water (i.e., change of use of existing supplies) that may serve as additional supply from a local or regional perspective, but would not augment supplies from a statewide perspective. In addition, implementing some strategies, like water dependent recreation or ecosystem restoration may increase total water demands.

Specific Notes (a) – (pp):

(a), (b) Agricultural Water Use Efficiency – Reduce demand. Bay-Delta Program estimates for 2020 level of demand and Bay-Delta Program Solution Area only. This does not include Imperial Irrigation District water transfer. Subject mater experts are developing statewide estimates. Water savings estimates are from CALFED Ag WU Efficiency Technical Appendix and Colorado River Quantification Settlement Agreement.

The cost estimates are derived from potential on-farm and district wide efficiency improvements associated with "real water savings". Details of estimates and assumptions are in the CALFED WUE Program Plan (Final Programmatic EIS/EIR Technical Appendix- July 2000). Water savings and associated costs for All American Canal and Coachella Branch Canal lining are not included in the cost analysis.

(c), (d) Urban Water Use Efficiency – Reduce demand. 1) Bay Delta Program (2000) Net Water Estimates; and 2) Pacific Institute end use study (2003). Cost estimate in progress by staff.

(e) Conveyance – Cost estimated = $1.125 billion, as follows:

($1 billion for CALFED Delta conveyance improvements) + ($125 million for Lining of the All American and Coachella canals) = $1.125 billion total cost.

(f), (g) System Reoperation – Augment supply or redistribute water. Supply benefit is based on future implementation of the Bay Delta Program's Environmental Water Account from willing sellers reoperating local and regional surface water projects. Implementation of other resource management strategies will often result in system reoperation.

(h), (i) Water Transfers – Supply benefits associated with water transfers come from implementing other resource management strategies, in particular, agricultural water use efficiency, system reoperation, conjunctive management, and temporary land fallowing (included in agricultural lands stewardship). Cost estimate in progress by staff.

(j), (k) Conjunctive Management & Groundwater Storage – Augment supply. Conjunctive Management – The supply benefits were derived from: 1) Proposition 13 Groundwater Storage Applications to DWR for fiscal year 2001-2002; 2) Association of Groundwater Agencies report entitled, "Groundwater and Surface Water in Southern California" (2000); 3) Natural Heritage Institute report entitled, "Feasibility Study of a Maximal Program of Groundwater Banking" (1998); 4) U.S. Army Corps of Engineers report entitled, "Conjunctive Use for Flood Protection" (2002); 5) Natural Heritage Institute report entitled, "Estimating the Potential for In-Lieu Conjunctive Management in the Central Valley" (2002). Cost estimates are extrapolated from Proposition 13 Groundwater Storage Applications to DWR for fiscal year 2001-2002. Cost estimates assume that the supply benefit is not restricted by Delta export constraints or conveyance capacity.

(l), (m), (n), (o) Desalination – Augment supply. Information and data are from "DWR October 2003 report "Water Desalination - Findings and Recommendations", California Coastal Commission's 2003 draft report "Seawater Desalination and the California Coastal Act" and a DWR Desalination Database based on reports and articles in newspapers, newsletters, technical journals and trade journals." Primary information sources for the database are "Water Desalination Report" (weekly newsletter), International Desalination Association's Worldwide Desalting Plants Inventory series (issued biennially since 1970), "International Desalination & Water Reuse Quarterly" and California Water News, DWR's daily compilation of water news in California.

(p), (q) Precipitation Enhancement – Augment supply. DWR staff analysis (2004).

Cost estimated = $.2 billion, as follows: ($7 million/year for cloud seeding activities) x (25 years until 2030) + ($2 million for initial environmental studies) = $177 million.

(r), (s) Recycled Municipal Water – Augment supply. *Water Recycling 2030*; Recycled Water Task Force (2003).

(t), (u) Surface Storage - CALFED – Augment supply. Bay-Delta Program Storage Investigations staff (2003). Cost estimate based on DWR and U.S. Bureau of Reclamation report entitled, "California Bay-Delta Surface Storage Program Progress Report," April, 2004.

(v) Surface Storage – Regional/Local – No statewide cost estimates available.

(w) Drinking Water Treatment & Distribution – Cost estimate based on a formal needs survey by the U.S. Environmental Protection Agency.

(x), (y) Groundwater/Aquifer Remediation – Supply augmentation by 2030 could be as high as 1 MAF per year if aquifers not presently being used are tapped. [1] Estimated investment by 2030 would be 20 billion dollars.

[1] Groundwater that is presently being treated may continue to require treatment before use in 2030, and other current sources of groundwater may require treatment in the future. These sources are already a part of the supply, so there may be no net "supply augmentation." Nevertheless, remediation is required to maintain existing supplies.

(z) Matching Water Quality to Use – Cost estimate based on CALFED estimates.

(aa) Pollution Prevention – Cost estimate based on a formal needs survey by the U.S. Environmental Protection Agency.

(bb) Urban Runoff Management – Cost estimates are included under Pollution Prevention. See note (o) above.

(cc), (dd) Agricultural Lands Stewardship – Redistribute water. Potential supply benefits from temporary land fallowing or permanent land retirement.

Cost estimate = $5.3 billion, determined as follows:

Total cost is the sum of three components: (A) financial assistance, (B) technical assistance and (C) land acquisition.

A: USDA estimate of unmet need for its conservation cost-share programs = ($80 million/yr) X (25 yr until 2030) = $2 billion;

B: USDA estimate of unmet need for field staff = (800 persons) X ($90,000/yr/person) X (25 yr until 2030) = $1.8 billion

C: conservation easements on about 9% of 11.4 million total acres of farmland = (1 million acres) X $1500/acre = $1.5 billion

A + B + C = $2 billion + $1.8 billion + $1.5 billion = $5.3 billion.

(ee), (ff) Economic Incentives (Loans, Grants, and Water Pricing) – Supply benefits obtained indirectly by providing incentives for changes to water management behavior by agencies and individuals. Program administration cost is the only direct cost.

(gg) Ecosystem Restoration – Cost estimate = $7.5 –11.25 billion, as follows:

($150 million/year for CALFED activities) X (25 years until 2030) = $3.75 billion for CALFED area.

($3.75 billion) X (an expansion factor of 2 or 3 to cover areas outside CALFED) = $7.5 –11.25 billion

(hh) Floodplain Management – Cost estimate = $475 million, as follows:

($57 million for Flood Protection Corridor Program, disbursed over 3 years) = ($19 million/yr) X (25 years until 2030) = $475 million

(ii), (jj) Recharge Area Protection – The water supply benefit and associated cost is included in the strategy, conjunctive management and groundwater storage.

(kk) Urban Land Use Management – No statewide cost estimates available.

(ll) Water-Dependent Recreation – Cost estimate considers construction of 4, 100-site campgrounds, at $3.5 million each.

(4 campgrounds) x ($3.5 million/campground) = $14 million

(mm) Watershed Management – Costs for planning, communication, and decision making processes for local and regional watershed management efforts. Assessments, planning functions, public decision-making forums are the focus of most of the expenditures.

Period (years)	Assessment-Planning [2] ($ million)	Public Process [3] ($ million)	Projects [4] ($ million)	Total for period
2004-2009	$10-37.5	$8-16	$14-80	$160 - 667
2010-2015	$10-30	$8-16	$14-88	$160 - 804
2016-2030	$10-25	$8-16	$14-100	$160 – 2,115
Total				$480 – 3,586

[2]Assessment/Planning: From CALFED Finance Plan:
Annual cost 2004 period
Assessment and Planning $4-15 million,
Public Process $2-4 million, (listed as technical assistance in Finance Plan)
Annual cost 2010 period
Assessment and Planning $4-12 million
Public Process, $2-4 million
Annual cost 2016 period
Assessment and Planning $4-10 million
Public Process, $2-4 million

[3] The CALFED service area represents a portion of the State. For Assessment and Planning, the service area is estimated as 40% of statewide need and for Public Process as 25% of statewide need. Therefore, statewide Assessment and Planning = 2.5 x CALFED value, and Public Process = 4 x CALFED value.

[4] For Projects, CALFED service area is estimated to be 25% of the statewide need.

(nn) Regional Integrated Planning & Management – Assumes $1 million per hydrologic region per year.
($.001 billion/hydrologic region/year) x (10 hydrologic regions) x (25 years) = $250 million

(oo) Research & Development – Assumes $10 million per year for 25 years.
($.010 billion/year) x (25 years) = $250 million

(pp) Science – Costs for supporting science programs are assumed to be 3 to 5 percent of total implementation costs.